Trauma, Resilience, and Math Learning: African American Students' Perspectives on Adverse Childhood Experiences

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ABSTRACT

This qualitative study investigates how Adverse Childhood Experiences (ACEs) shape the mathematical learning experiences of ten African American community college students from urban backgrounds. While ACEs are known to influence mental health and cognitive development, their specific impact on mathematics learning remains underexplored—especially among historically marginalized populations. Guided by Contemporary Trauma Theory, the Theory of Allostasis, and the Ecological Assets framework, this study reveals how trauma manifests in executive functioning challenges, affective responses, and learning behaviors. Despite these obstacles, students demonstrated significant resilience, supported by ecological assets such as mentoring, supportive relationships, and culturally responsive environments. Findings underscore the importance of trauma-informed, equity-focused approaches in STEM education and call for a reexamination of deficit narratives around mathematics achievement.

Keywords: Adverse Childhood Experiences, African American students, ecological assets, executive functioning, mathematics learning, resiliency, trauma-informed pedagogy.

INTRODUCTION

The persistent underperformance of African American students in mathematics has been widely documented (NAEP, 2020) and is frequently linked to structural inequities, including limited access to qualified educators, rigorous instructional

content, and adequate educational resources (Darling-Hammond, 2010; Hanushek et al., 2019; Johnson & Kritsonis, 2006b; Snipes & Waters, 2005). However, the role of trauma—particularly Adverse Childhood Experiences (ACEs)—in shaping mathematical learning trajectories remains insufficiently examined in the literature. African American students, especially those residing in urban contexts, are disproportionately exposed to ACEs and chronic stressors, including community violence and systemic disadvantage (Watt et al., 2021; Carrion & Wong, 2012).

This study seeks to illuminate the intersection between trauma and mathematics education by exploring how such experiences influence students' cognitive and emotional engagement with mathematics and how some learners demonstrate resilience in the face of these adversities. ACEs are potentially traumatic events that occur during childhood, such as abuse, neglect, or household dysfunction (Felitti et al., 1998). These experiences can significantly affect children's emotional, psychological, and cognitive development, potentially influencing academic performance and engagement. Research shows that the prevalence of ACEs is highest among Black and Hispanic youth (Sacks & Murphey, 2018), with children in urban settings particularly vulnerable to both community and domestic stressors. The neurological and psychological consequences of trauma, including impaired executive functioning, emotional dysregulation, and memory disruptions, pose unique challenges to success in mathematics, a subject requiring high levels of cognitive engagement (Carrion & Wong, 2012; Haft & Hoeft, 2017). Despite the known effects of ACEs on learning, there is a limited understanding of their specific influence on mathematics achievement. This study addresses that gap, centering the voices of African American students who experienced ACEs and succeeded academically in math, thus reframing dominant deficit narratives.

Research questions:

- RQ1. How do African American CC students who experienced childhood adversities describe their response to ACEs?
- RQ2. How do African American CC students who experienced childhood adversities describe the influence on their mathematical learning?

LITERATURE REVIEW

African American students' mathematics achievement remains consistently below national averages, reflecting persistent opportunity gaps and systemic disparities (Basch, 2011; Hanushek et al., 2019; Horn, 2003; Hung et al., 2019; NAEP, 2020; Riegle-Crumb & Grodsky, 2010). Building on this context, the study examines how Adverse Childhood Experiences (ACEs) impact cognitive functioning and mathematics learning among African American students (Duncan & Murnane, 2011; Martin-Paez et al., 2019).

Background on ACEs, Trauma, and Cognition

ACEs represent a significant form of trauma capable of producing lasting psychological, mental, and physical health challenges (Basch, 2011; Edman et al., 2016; Kamenetz, 2017; Larson et al., 2017; Mall et al., 2018). Events such as abuse, neglect, domestic violence, and caregiver mental illness expose students to chronic stress, influencing cognitive development and academic achievement (Basch, 2011; Dyce, 2015; Ford et al., 2015; Sitler, 2009; Sonu et al., 2021).

Research shows that persistent exposure to environmental stressors affects brain development, thereby compromising learning capacities (DePrince et al., 2009; Holland et al., 2020; Larson et al., 2017). Specifically, trauma affects neurobiological systems that govern executive functioning, attention, self-regulation, and memory directly impacting academic performance (Porche et al., 2011).

While trauma's effects are well-established, not all students exposed to ACEs suffer identical outcomes. Individual resilience and coping strategies appear critical in moderating these effects (Haft & Hoeft, 2017; Palmer et al., 2014).

Coping Mechanisms and Cognitive Vulnerabilities

Research on stress and executive functioning highlights variation in individual susceptibility to trauma's cognitive effects. Students with higher baseline working memory may paradoxically suffer greater declines in complex problem-solving under acute stress (Palmer et al., 2014). Stress-related hormonal disruptions further impair the brain's ability to regulate learning and memory processes, with chronic exposure compounding these effects (de Kloet & Joëls, 2023; Palmer et al., 2014).

Coping strategies also influence academic trajectories. Sheffler et al. (2019) identified two dominant responses to ACEs: problem-focused coping (PFC) and avoidant emotion-focused (AEF) coping. Trauma often pushes even students with strong cognitive capacities toward less effective coping strategies, contributing to declines in academic engagement and resilience (Kalmakis et al., 2020). Biological factors, such as cortisol reactivity and allostatic load, further explain why some students experience heightened cognitive impairments following ACEs (Haft & Hoeft, 2017). Thus, the interplay between biological vulnerability and coping mechanisms is crucial in understanding learning disparities.

ACEs and Discrimination

In addition to direct trauma, experiences of discrimination compound the effects of ACEs, especially for African American students (Helminen et al., 2022).

Chronic exposure to systemic racism intensifies stress, mental health challenges, and educational disparities. Researchers argue that racial discrimination not only exacerbates the psychological consequences of ACEs but also undermines academic confidence and motivation in mathematics (Battey et al., 2021; Munter & Haines, 2019).

Studies highlight the urgent need for inclusive, anti-racist mathematics instruction that recognizes these intersecting adversities (Schmidt et al., 2021; Castillo & De Losada, 2020). Promoting a sense of belonging and dismantling stereotypes are critical steps toward mitigating these compounded barriers.

Psychological Effects of Trauma on Cognition and Learning

Trauma disrupts the brain's regulatory architecture, impairing emotional regulation, behavioral control, and cognitive functioning (Goodman, 2017; Kalmakis et al., 2020; Palmer et al., 2014). Internalizing symptoms such as anxiety and externalizing behaviors such as aggression are manifestations of trauma's impact on self-regulation (Carrion & Wong, 2012; Goodman, 2017). These disruptions, in turn, interfere with classroom engagement and academic persistence, particularly in cognitively demanding subjects like mathematics (Alvarez, 2020; Boyraz et al., 2013).

Mathematics stands out from other subjects due to its unique and specific cognitive demands. While many academic disciplines involve memorization, language comprehension, or creative thinking, mathematics requires a blend of abstract reasoning, symbolic manipulation, and multi-step problem-solving. This distinct nature of mathematics is evident in the reliance on abstract reasoning, the coordination of multiple cognitive systems, and its demand for logical, structured thinking. These unique cognitive demands make math a challenging subject, particularly for students who struggle with memory, focus, or the ability to simultaneously process multiple forms of representation, as shown in the research on cognitive load and math comprehension (Carrion & Wong, 2012; Duval, 2006). This highlights the intersection/interaction of the cognitive complexities specific to mathematics and ACEs.

ACEs disrupt critical cognitive functions, particularly working memory and emotional regulation, essential for learning mathematics (Carrion & Wong, 2012; Goodman et al., 2012). Working memory and number sense play a crucial role in mathematical problem-solving (Bernabini et al., 2021; Fuchs et al., 2010). The strain ACEs place on cognitive resources can severely impair these functions, making it difficult for students to retain and process information effectively, including problem-solving skills essential for mathematics proficiency (DePrince et al., 2009; Haft & Hoeft, 2017; Vohs & Baumeister, 2004). Compounding these challenges, trauma-exposed students often experience hypervigilance and heightened emotional reactivity, further reducing their available cognitive bandwidth for academic tasks (Craig, 2016; Hinojosa et al., 2019).

Trauma and Resiliency

Despite trauma's detrimental effects, many students demonstrate remarkable resilience. Neuroplasticity and adaptive brain mechanisms can foster recovery and academic persistence (Craig, 2017; Goodman, 2017; Kalmakis et al., 2020). However, chronic adversities weaken these systems, diminishing students' ability to regulate emotions, behavior, and cognition over time (Palmer et al., 2014).
Building resilience requires intentional support systems that address both the physiological and psychological dimensions of trauma (Alvarez, 2020; Holland et al., 2020). Recognizing these dual pathways, damage and repair is essential for fostering academic success among trauma-exposed students.

Students' Cognition, Emotion, and Behavior

The impact of trauma on cognition, emotions, and behavior is deeply interconnected. As executive functioning erodes, students struggle to manage emotions, engage in self-regulation, and perform academic tasks, particularly in mathematics (Carrion & Wong, 2012; Haft & Hoeft, 2017; Vohs & Baumeister, 2004).
Behavioral manifestations ranging from disengagement to disruptive conduct are often misinterpreted as intentional defiance rather than symptoms of trauma (Sitler, 2009; Walker & Goings, 2017). This misinterpretation exacerbates punitive responses rather than promoting healing, further hindering students' academic progress.

Trauma and the Learning of Mathematics

Mathematics learning uniquely challenges trauma-exposed students by demanding sustained cognitive engagement, emotional regulation, and abstract reasoning (Duval, 2006). Trauma-compromised students often lack the mental bandwidth required for these demands, resulting in struggles with problem-solving, procedural fluency, and conceptual understanding (Carrion & Wong, 2012; Haft & Hoeft, 2017).

As research indicates, trauma not only impairs cognitive operations essential for mathematics but also fuels anxiety and avoidance behaviors that disrupt learning (Goodman, 2017; Palmer et al., 2014). Without trauma-informed support, many students remain marginalized in mathematics spaces.

Conceptual Framework

This study's conceptual framework integrates three theoretical lenses to examine the psychological and physiological impact of trauma on cognition and mathematics learning (ML): (a) the Contemporary Theory of Trauma (CTT), (b)

the Theory of Allostasis (TOA), and (c) Ecological Assets (EA). Together, these frameworks provide a comprehensive foundation for understanding how trauma, particularly ACEs, influences academic functioning among African American students. ACEs are known to impair cognitive processing and emotional regulation, factors central to ML. This study draws upon participants' lived experiences to interpret how trauma affects their learning processes, particularly in mathematics.

Contemporary Theory of Trauma (CTT)

CTT offers a paradigm shift in how trauma is conceptualized, viewing individuals not as deficient but as survivors requiring support to recover from psychological and physiological effects that impair cognitive resilience (Goodman, 2017). The theory highlights five central properties of trauma—dissociation, attachment, reenactment, long-term effects in adulthood, and impairment in emotional capacities (IMEC). For this study, the analysis centers on three of these—dissociation, attachment, and IMEC as they are most directly observable in classroom behavior and ML.

Dissociation. Dissociation is a defensive mechanism that allows individuals to psychologically disengage from overwhelming stress (Goodman, 2017; Herman, 1992). For students, this may manifest passivity, lack of focus, or disengagement from instruction—behaviors linked to AEF coping strategies (Sheffler et al., 2019). These behaviors can inhibit cognitive processing, especially in mathematics, where sustained attention is critical (Craig, 2016; Walker & Goings, 2017).

Attachment. Attachment refers to students' ability to form trusting interpersonal relationships (Goodman, 2017; Fearon & Roisman, 2017). ACEs can undermine this ability, leading to heightened mistrust, hypervigilance, and relationship sabotage in academic settings (Herman, 1992; Sheffler et al., 2019). In the classroom, such behaviors may include verbal aggression, defiance, or social withdrawal, often resulting in disciplinary actions that further reduce opportunities for mathematics instruction (Dyce, 2015; Sitler, 2009).

Impairment in Emotional Capacities (IMEC). IMEC reflects the breakdown of self-regulation and emotional control due to trauma's impact on executive functioning (Goodman, 2017; Kalmakis et al., 2020). These impairments are often mistaken for behavioral problems, such as inattention or opposition, and can severely disrupt classroom learning (Craig, 2016; Thompson & Massat, 2005). IMEC links closely with the neurobiological disruptions outlined in TOA.

Theory of Allostasis (TOA)

TOA deepens the analysis of trauma's physiological effects, focusing on how chronic stress disrupts neuroplasticity and short- and long-term resilience (Kalmakis et al., 2020; Kalia et al., 2021). Allostasis involves the body's efforts to maintain stability through change; when overwhelmed by ACEs, this adaptive capacity breaks down, impairing learning-related cognitive functions such as memory, attention, and problem-solving (Carrion & Wong, 2012; Porche et al., 2011). TOA thus complements CTT by explaining how trauma alters biological systems that support learning, particularly in cognitively demanding subjects like mathematics.

Ecological Assets (EA)

The Ecological Assets concept addresses the protective factors that help students buffer the effects of trauma. Emotional and social supports such as family involvement, peer networks, and community engagement can foster resilience and facilitate academic recovery (Ford et al., 2015; Sonu et al., 2021). These supports form the basis of Positive Youth Development (PYD), which comprises five key components: competence, confidence, character, connection, and caring, including community support (Lerner et al., 2012; Li et al., 2010).

EA moderates the impact of allostasis and trauma by restoring emotional and mental energy, promoting coping strategies, and reinforcing positive self-concepts (Craig, 2016; Terrasi & De Galarce, 2017). Supportive relationships serve as a counterbalance to ACE-related distress, enabling students to remain engaged in mathematics learning (Walker, 2006). In particular, Walker's (2006) research shows how Black and Latino students used peer-based networks to foster academic resilience and improve performance, echoing the community-based strengths highlighted in EA research (Goodman, 2017; Sciaraffa et al., 2018).

Together, CTT, TOA, and EA provide a cohesive conceptual framework for understanding how trauma affects African American students' ML. CTT highlights the psychological manifestations of trauma in behavior and cognition; TOA explains the physiological disruptions to learning capacity; and EA outlines the social supports that mitigate these effects. This integrated framework guided both the development of a priori codes for data analysis and the interpretation of participants' lived experiences with ACEs and mathematics learning challenges.

RESEARCH METHOD

This study employed a descriptive qualitative research design using in-depth interviews to explore African American CC students' perceptions of how ACEs influenced their ML in secondary school. A descriptive qualitative research design was ideal for this study because it allowed participants to describe their experiences in a manner that captured the phenomenon (Creswell, 2014). The

research design incorporated purposive sampling, semi-structured interviews, and thematic analysis using both inductive and deductive strategies.

Table 1

Participants' Demographic Characteristics

Name	Gender	Age	High School	HS GPA	Math Class, Grade Earned
Angel	Female	20	Public, Queens, NY	2.5	Algebra 2 Grade: D
Peters	Male	23	Private Austin, TX	3.1-3.5	College Algebra Grade: C
Stella	Female	25	Public Philadelphia, PA	3.59	College Algebra Grade: B
Mary	Female	25	Public Miami, FL	2.6 - 3	College Algebra Grade: D
Victoria	Female	26	Public, Magnet, LA, CA	3.6 - 4	College Algebra Grade: B
Linda	Female	26	Public Weston, FL	3.6	College Algebra Grade: B
Joy (JH)	Female	25	Public Albany, NY	3.5	College Algebra Grade: B
Toni	Female	23	Public, Magnet Weston, FL	3.5	College Algebra Grade: C
Justin	Male	24	Public New York, NY	2.6 - 3	Sets & Function, Grade: C
Joe	Male	28	Public Nashville, TN	3.1-3.5	College Algebra D

HS = High School

Participants.

Ten African American community college (CC) students were purposively selected based on their self-reported experiences with ACEs during their secondary education. Participants ranged in age from 23 to 28 and were enrolled in the same CC, although they had attended high schools in different states. Most participants

resided with their parents during secondary school, while two lived with extended family members.

Recruitment targeted students with urban secondary school backgrounds, where trauma and ACEs are often more prevalent due to socioeconomic disparities (Ladson-Billings, 2021; Naik, 2019). Recruitment was conducted through flyers, social media, and referrals, using a combination of purposeful and snowball sampling to ensure alignment with the study's inclusion criteria (Campbell et al., 2020; Parker et al., 2019; Johnson et al., 2020). Thirteen students completed an eligibility questionnaire based on the ACEs instrument, and ten qualified and agreed to participate. Ethical protocols were followed in accordance with institutional guidelines. Informed consent was obtained, and participants were assured of their confidentiality. The demographic data, and academic outcomes were summarized in Tables 1, onset and duration of ACEs in Table 2.

Table 2
Onset and Duration of the Participants' ACEs

Name	Onset of ACEs	Duration
Angel	Ages 7-8 (2nd Grade)	2 years through 4th/5th Grade
Peters	Ages 7-8 (2nd Grade)	6 years through 8th Grade
Stella	Age 13 (7th Grade)	5 years through 12th Grade, into adulthood
Mary	Ages 13-14 (8th Grade)	5 years through 12th Grade, into adulthood
Victoria	Age 9 (3rd Grade)	9 years through 12th Grade
Linda	Ages 5-6 (1st Grade)	2 years, at varied intervals
Joy	Ages 10-11 (5th Grade)	7 years through 12th Grade
Toni	Age 6 (1st Grade)	10 years, through 11th Grade
Justin	Age 10 (5th Grade)	3 years, through 8th Grade
Joe	Age 14 (8th Grade)	3 years, through 11th Grade

Data Collection.

Data collection was carried out in two phases: (1) completion of the ACEs questionnaire and demographic data (Table 4) and (2) participation in individual semi-structured interviews via Zoom. The ACEs questionnaire was used to screen participants based on childhood adversities encountered that may impact cognitive and emotional development.

Qualified participants were invited to participate in 30- to 45-minute virtual interviews. The interviews were designed to explore students' reflections on how trauma influenced their academic engagement, focus, and emotional well-being during secondary mathematics instruction. The open-ended interview questions covered participants' academic performance, emotional challenges, and support systems (Appendix A). All interviews were audio recorded with consent, transcribed verbatim, and anonymized using pseudonyms. To ensure accuracy, participants were asked clarifying questions and given the opportunity to verify their responses. I maintained observation notes during each session as a backup and for triangulation. Participants were asked to verify key information provided in their questionnaire responses, including high school GPA, SAT scores, and mathematics course history.

Data Analysis.

Interview transcripts were analyzed using thematic analysis, guided by Braun and Clarke's (2006) six-phase framework: familiarization, coding, categorization, theme development, refinement, and final analysis. Analysis combined inductive and deductive approaches, informed by a priori codes derived from the conceptual framework: attachment, dissociation, impairment in emotional capacities (IMEC), resiliency, and ecological assets.

I manually coded the transcripts, reading each multiple times to identify repeating ideas and patterns related to the research questions. Codes were organized into categories and themes reflective of participants' lived experiences. Highlighted excerpts were color-coded by theme, and emerging thematic patterns were compared against the conceptual framework (Braun & Clarke, 2021; Locke et al., 2022). A second coder reviewed the data to enhance reliability.To ensure rigor, member checking was employed: participants reviewed summaries of their interviews to confirm the accuracy of interpretation (Candela, 2019). Triangulation of codes and consistency in thematic development supported confirmability.

RESULTS

To understand how African American CC students described the influence of ACEs on their ML and their resilience in navigating their ACEs, a descriptive qualitative approach was used to answer the two research questions (RQs).

The following three overarching themes emerged.
1. Participants' Descriptions of Affective Responses to ACEs' Influences
2. Participants' Descriptions of ACEs' Influence on Learning, including ML
3. Participants' Descriptions of Navigating Adversities through Resiliency and Ecological Assets

These themes were generated using a priori codes aligned with the study's conceptual framework, which includes CTT, the TOA, and EA.

Theme 1: Affective Responses to ACEs (RQ1)

Participants described how ACEs influenced their socio-emotional development, self-concept, and interpersonal interactions, which included isolation, low self-esteem, depression, and distrust of others. These affective responses influenced their ability to form relationships and navigate academic environments. The following categories emerged:

- **Lack of Confidence in Social Settings and Isolation**: Participants reported difficulty engaging with peers, low self-esteem, and communication challenges. Several described feeling embarrassed, discriminated against, or socially withdrawn. Participants such as Angel and Stella described feelings of social disconnection. Angel stated, "I don't have a social life, and I was unable to speak up and, you know, ask questions." Stella added, "I couldn't really socialize with all the students in school."

- **Depression and Emotional Distress**: At least three participants discussed experiencing depression and mood swings, impacting their social and academic engagement. Peters and Justin explicitly described experiences with depression. Peters recounted, "Mentally, it had a great impact on me because... I had depression, which was caused by my adverse childhood experience."

- **Distrust and Fear of others**: Participants expressed difficulty forming trusting relationships and a persistent sense of fear or emotional detachment due to past abuse or neglect. Mary and Joe expressed mistrust toward peers and adults. Joe recalled, "I was always being frightened and observing... I felt terrified, like something might happen to me." Mary said: "I tend to love less… I feel like most people don't love you… maybe they just come to you because of what they stand to gain."

These affective responses aligned with the conceptual framework's emphasis on attachment disruption and the internalization of trauma. Participants' descriptions underscored how affective impairments manifested in avoidance, withdrawal, and social isolation, which negatively impacted their educational experiences.

Theme 2: ACEs' Influence on Learning and Mathematics/Mental Engagement (RQ2)

The second theme highlights participants' perceptions of how ACEs influenced their learning, especially in mathematics. Participants shared how ACEs disrupted their ability to focus, concentrate, and remain engaged during mathematics instruction. These influences were both voluntary (avoidance) and involuntary (emotional and cognitive impairments). Two categories emerged:

- **Avoidance Behaviors**: Some participants voluntarily disengaged from instruction (e.g., doodling, daydreaming) as a coping mechanism to avoid traumas-related thoughts. These behaviors are consistent with dissociative strategies. Justin said, "During math class or other classes, I would just draw or write in my notes and wouldn't pay attention."
- **Involuntary Lack of Focus, Attention, and Concentration - Cognitive Impairments**: All participants described difficulty focusing, concentrating, and remaining mentally present during instruction. These symptoms reflect emotional and mental exhaustion, consistent with impaired emotional capacities (IMEC). Participants frequently connected their inability to engage in ML to unresolved trauma. Victoria explained, "Anytime I got to remember the way my parents treated me, I could not concentrate in class. Sometimes I burst into tears."

  Toni added, "There were too many things on my mind. So, I lacked concentration. It affected my learning."

  Peters said: "It affected my learning because going to school with a troubled mind… was a hindrance to my concentration."
- **Impacts on Mathematics Performance.** Mary described how her trauma influenced her math performance: "I lost concentration in school most of the time... that's why I was very bad at math."

  Victoria said: "I could not really concentrate on math class… anytime I got to remember the way my parents treated me, I started crying."

These findings provide qualitative evidence that trauma-induced cognitive disruptions played a significant role in their academic difficulties, particularly in ML.

Theme 3: Navigating Adversities through Resiliency and the Role of Ecological Assets (RQ1 & RQ2)

Despite their adversities, participants described developing resilience and finding ways to persist academically despite the challenges. They described their efforts to overcome adversity through inner strength, supportive relationships, and available resources. Two categories characterized this theme:

- **Increased Resiliency Leading to Task Completion**: Participants described motivation stemming from personal goals, such as graduating or avoiding punishment. They found ways to maintain focus despite trauma. **Self-Driven Resilience.** Angel said, "Self-determination and the fact that I didn't want to be a never-do-well... the determination not to fail was what really pushed me."
- **Influences of Support Systems**: Most participants identified ecological assets such as family, friends, peer groups, and teachers as essential to navigating their trauma. Others described receiving help from therapists. Even participants without strong external support cited internal motivation and coping strategies that aided their academic perseverance.
- **Support from Therapists, Teachers, and Peers.** Joe credited his success to a supportive math teacher who offered extra lessons. Justin highlighted the influence of a close friend: "My friend encouraged me, took time to explain homework and classwork." While Stella said: "My therapist helped me realize how to stay calm and focus… I read, play games, or watch videos."
  Role of Peer Groups. Participants such as Joy and Victoria described group work with peers as instrumental in helping them focus and complete academic tasks.

These narratives highlight the crucial role of socio-ecological and psychological support in fostering academic resilience. Access to caring adults and safe environments contributed to students' ability to succeed in math despite trauma.

RQ1: Affective Responses to ACEs
Participants described emotional dysregulation, isolation, distrust, and diminished self-worth as significant responses to ACEs. For example, Peter reported, "I wasn't mentally okay... there were times when I felt depressed... I didn't trust anyone." These descriptions aligned with CTT and demonstrated challenges in emotional processing, attachment, and maladaptive internalization (Goodman, 2017; Herman, 1992).

RQ2: ACEs and Mathematics Learning (ML)
All but one participant described difficulties with focus, attention, and concentration in mathematics. These executive functioning challenges hindered

their ability to focus, concentrate, retain skills, process multi-step problems, and regulate emotions during instruction. Participants' descriptions of dissociation and mind-wandering revealed trauma's impact on cognitive engagement (Carrion & Wong, 2012; Haft & Hoeft, 2017). Linda, a discrepant case, reported minimal impact on ML due to early intervention and removal from the traumatic environment.

Ecological Assets and Resilience.
Participants credited support systems of family, peers, teachers, mentors, and therapists as crucial for developing resilience. Themes of self-motivation and inner strength emerged as key psychological assets. Joe explained, "You need to get that out of your head to concentrate." Angel emphasized, "Determination not to fail was what pushed me."

All participants shared experiences of ACEs that affected their emotional, social, and cognitive development. These experiences manifested in affective challenges (e.g., isolation, fear, depression), cognitive disruptions (e.g., lack of attention, concentration, focus), and behavioral coping mechanisms (e.g., avoidance). However, their narratives also revealed substantial resilience, with many overcoming adversities through ecological support and personal motivation. While not all participants reported identical impacts, the patterns suggest ACEs were a pervasive influence on both learning in general and ML in particular.

DISCUSSION AND CONCLUSIONS

This study offers a novel contribution by linking ACEs to math-specific cognitive challenges and highlighting the role of ecological assets in student resilience. The findings indicate that trauma impairs executive function, particularly in mathematics, where attention, memory, and precision are critical. However, it is important to note that these observations/analyses are based on the participants' self-reported experiences and perceptions. In this study, it was not possible to measure adaptive or executive functioning, nor was it possible to measure neuroplasticity or levels of stress hormones.

The literature showed that due to allostatic load, trauma victims experience impairment of the executive functioning skills of self-regulation, which governs attentional or self-control, focus, and the ability to remain on-task (Carrion & Wong, 2012; Kalmakis et al., 2020; Kamenetz, 2017; Palmer et al., 2014). While the allostatic load of participants was not measured, their descriptions of the perceived influence of ACEs on ML mirrored findings or results in the literature that demonstrated the interaction and interconnection of the physiological and psychological effects of trauma on participants' emotional, mental, and cognitive functioning (Goodman, 2017; Kalia et al., 2021). However, the findings also

counter deficit narratives by showing that students demonstrated agency, resilience, and success.

Affective Responses to ACEs

Participants' descriptions of their affective responses to ACEs revealed deep psychological impacts that aligned with established trauma research. They experienced low self-esteem, social withdrawal, depression, and difficulties with interpersonal trust. These findings are consistent with the literature that identifies attachment challenges as a common outcome of early trauma (Goodman, 2017; Haft & Hoeft, 2017; Kalmakis et al., 2020). For instance, Peters' narrative reflected the consequences of compromised attachment—his reclusiveness, fear, and depression mirrored trauma's disruption of the limbic system and emotional self-regulation (Anderson et al., 2023).

This theme substantiates the conceptual tenets of the CTT, particularly the role of attachment in emotional processing. Participants' inability to trust others, form relationships, or communicate effectively speaks to internalized maladaptive behaviors common in trauma survivors (Herman, 1992; Sheffler et al., 2019). Interestingly, participants reported no externalizing behaviors (e.g., aggression or rule-breaking), which contrasts with existing literature. This may be due to social desirability bias or the internalization common among abuse victims (Larson, 2019; Moylan et al., 2010).

ACEs and Mathematics Learning

The second theme, how ACEs influenced participants' mathematics learning revealed that all but one participant experienced cognitive disruption related to trauma, such as dissociation, lack of focus, and difficulty concentrating. These disruptions hindered their ability to engage with mathematical content and maintain attention in class. These findings support research linking ACEs to impaired executive functioning, including working memory, emotional regulation, and attention, all essential for mathematical reasoning (Carrion & Wong, 2012; Kalia et al., 2021).

Participants' experiences also affirmed the theory of allostasis, which posits that prolonged stress alters brain development and functioning, compromising the cognitive capacity needed for learning (Kalmakis et al., 2020). For example, Victoria described an inability to "calm down to listen," while Angel and Peters detailed mental exhaustion that interfered with learning. These descriptions exemplify how allostatic loads translate into compromised academic performance.

Additionally, dissociation as seen in Angel and Justin's use of mental avoidance strategies during class reflects AEF coping and aligns with trauma

literature (Sheffler et al., 2019). Despite these barriers, participants' reflections show the interaction between trauma and the unique cognitive demands of mathematics, which relies heavily on abstraction, working memory, and logical reasoning (Duval, 2006; Fuchs et al., 2010).

Linda's case was unique. She attributed her minimal academic disruption to the short duration of her ACEs and early removal from the trauma source, suggesting that the intensity and timing of trauma exposure may shape its academic consequences, a potential area for future research.

Resilience and Ecological Assets

Despite their adversities, all participants demonstrated resilience. The third theme highlighted the role of EA, such as peer support, mentoring, therapy, and self-motivation, in helping students cope with trauma and persist academically. Some students, including Joe, Justin, and Linda, cited supportive teachers or mentors who created safe academic spaces. Others, such as Angel and Mary, relied heavily on internal motivation and goal-setting.

This finding supports the Ecological Assets model, which emphasizes the protective role of supportive relationships and environments in mitigating the effects of trauma. Group work, counseling, music, and peer encouragement emerged as essential tools that helped students remain in school and improve their academic engagement. The use of mindfulness techniques and self-affirmation also aligns with literature on trauma-informed educational practices (Craig, 2016). Participants' resilience underscores the importance of strength-based approaches in education. Although their ACEs posed significant barriers, students found ways to cope and succeed, demonstrating that educational institutions can be sites of healing and growth when equipped with trauma-sensitive structures.

This study provides evidence that ACEs deeply influence African American students' learning, particularly in mathematics, by affecting emotional stability, social interaction, and cognitive function. However, the presence of supportive relationships and environments helped mitigate these impacts. African American students' resilience should be viewed as a resource and intentionally nurtured through trauma-informed practices and inclusive pedagogies.

The findings contribute to a growing body of literature on trauma and learning, particularly for marginalized populations in STEM fields. The narratives reveal how emotional regulation, academic support, and safe environments are foundational to educational success. Addressing Adverse Childhood Experiences (ACEs) must be central to equity-focused reform in mathematics education.

IMPLICATIONS

This study contributes to understanding ACEs' influences on learning, specifically ML of African American students, and the cognitive implications related to ML. Based on the findings and analyses, trauma influenced ML, and ACEs were a plausible factor undermining the academic potential and ML of African American CC students. Based on the participants' described experiences and the support systems that facilitated their navigation of the influences of ACEs, this study suggests the need to provide a conducive learning environment and instructional methods that enable students' easy, smooth, and stress-free learning, as they already have limited cognitive bandwidth challenges.

Implications for Practice: Educators should be trained in trauma-informed pedagogy to support emotional regulation, relationship-building, and engagement, particularly in math classrooms. Instruction should be culturally responsive, integrating students' lived experiences and challenging racial bias. Schools must also strengthen support systems through counseling, mentorship, and community partnerships to foster resilience and academic persistence.

Implications for Policy: Teacher preparation programs should incorporate ACEs-related content to equip educators with the trauma-informed competencies necessary for effective teaching. Institutions must adopt policies that embed trauma awareness into their curriculum, discipline, and student services. Additionally, schools should utilize ACEs data ethically to design targeted interventions that do not stigmatize students.

Implications for Future Research: Further research is needed on the effectiveness of trauma-informed mathematics instruction for students of color. Longitudinal and mixed-methods studies should examine the impact of ACEs duration and the protective role of ecological assets in STEM persistence. Investigating the intersection of racial trauma, school climate, and STEM achievement remains a critical area for exploration.

This study amplifies the voices of African American students whose experiences with trauma have too often been overlooked in mathematics education research. By centering their narratives, the study offers a call to action: to humanize learning spaces, dismantle deficit perspectives, and cultivate the strengths that students bring. When students are seen, supported, and believed in, their ability to learn, even in subjects like mathematics, can flourish despite adversity.

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Bio

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